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Renewable energy in the Palestinian Territories: Opportunities and challenges

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ABSTRACT

The Palestinian Territories relies on Israel for 100% of its fossil fuel imports and for 87% of its electricity imports. Total energy consumption in the Palestinian Territories is the lowest in the region and costs more than anywhere else in the Middle East. The purpose of this paper is to present the current energy situation in the Palestinian Territories, evaluate the potential of renewable energies in meeting part of the energy demand and discuss the challenges and benefits of using these types of energies. It is shown that the main renewable energy sources in the Palestinian Territories are solar, wind and biomass. Using the available renewable energy sources in the Palestinian Territories may significantly decrease the energy reliance on neighboring countries and improve the Palestinian population's access to energy. It is estimated that solar sources have the potential to account for 13% of electricity demand and wind energy for 6.6%. The conversion of animal waste into biogas has the potential to meet the needs of 20% of the rural population. The conversion of unused agricultural residue into biodiesel could replace 5% of the imported diesel.

Contents

1. Introduction

The use of renewable energies instead of fossil fuels provides many advantages to developing countries, including an increase of energy services in remote, rural areas, and is associated with general improvement of economic, social and environmental indicators [1–3]. The use of renewable energy resources around the world is linked intimately with effective approaches to sustainable development: they have a high potential to be cost-efficient, reliable, not damaging to the environment and designed appropriately for local conditions [4].

Given political, economic, environmental, geographic, social and infrastructural conditions in the Palestinian Territories, the advantages of renewable energy over fossil fuels there is greater than it is in other contexts. Small- and large-scale renewable energy systems have the potential to meet the growing energy demand in various parts of the Palestinian Territories where traditional energy systems have not yet reached, do not reach at affordable rates or do not reach reliably due to political conditions. The lack of a stable, reliable and sufficient energy system is one reason that Palestinian community development and economic development are curtailed, even before accounting for anticipated population growth and economic potential. Today, total energy consumption in the Palestinian Territories is the lowest in the region, costs more than anywhere else in the region and constitutes a higher proportion of household expenditure.

Numerous natural and political characteristics of the Palestinian Territories' small geographic area pose significant obstacles for the

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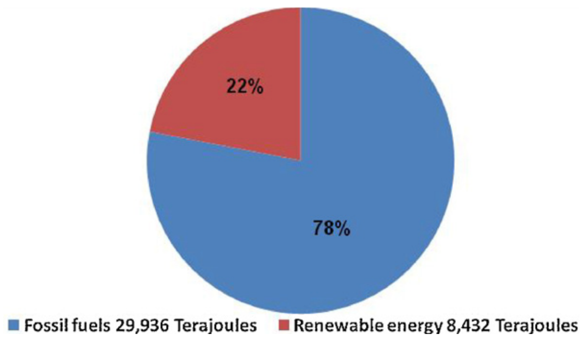

Fig. 1. Primary energy sources in the Palestinian Territories [6].

Palestinian energy sector. Most fundamentally, the land is nearly devoid of natural resources for the production of fossil energy. There is no physical contiguity between the Gaza Strip and the West Bank and East Jerusalem. Gaza's isolation presents technical and political challenges for transporting, storing, importing and exporting energy. The land comprising the West Bank and East Jerusalem has been subjected to extensive internal and external divisions for political reasons, as Israeli policies and practices in occupying, settling and controlling portions of this land impede or categorically prohibit the development of energy-related infrastructure and activity.

As a result of these conditions, there is no interconnection between Palestinian utility regions [5]. The Oslo Peace Agreement divided the West Bank into Areas A, B and C where Area C indicates full Israeli civilian and military control. Approximately 60% of the land in the West Bank is Area C. The Israeli control of this expanse and the artificial divisions therein severely hinder the potential development of a traditional energy sector's infrastructure and regulation.

The objective of this paper is to provide an overview of the current energy situation in the Palestinian Territories and to analyze the potential impact, benefits and challenges of developing renewable energy sources there. The analysis includes a discussion of the anticipated strengths and weaknesses of potential renewable energy projects.

2. Current energy situation in the Palestinian Territories

The vast majority of fossil fuels consumed in the Palestinian Territories are imported, with the majority originating in Israel and with marginal percentages from Egypt and Jordan. Fossil fuels are principally consumed by the transportation sector. Fig. 1 shows the primary energy sources in the Palestinian Territories. The majority, 78%, are liquid fossil fuels, such as gasoline, diesel and liquefied petroleum gas, while the remaining 22% is renewable energy sources. Fig. 2 illustrates that diesel and gasoline account for 79% of the fossil fuels consumed in the Palestinian Territories. There is no consumption of solid fossil fuels in the Palestinian Territories. Fig. 3 demonstrates that 56% of renewable energy produced in the Palestinian Territories is solar energy from solar water heaters and 43% is biomass from wood, olive cake and charcoal. The biomass is mainly used for heating purposes. The only domestic production of traditional power takes place at the Gaza Power Plant, which has struggled to operate at more than half capacity since 2006 and especially since 2009 when the Israeli Air Force attacked it and when European Union funding of fuel shipments ceased.

A low level of consumption, in relative and absolute terms, characterizes the electricity sector in the Palestinian Territories. In 2009, the electricity consumption was 3808 GWh in the West Bank and 1606 GWh in the Gaza Strip – the lowest consumption rates in the region. The energy sector is defined by its dependence on fossil fuel

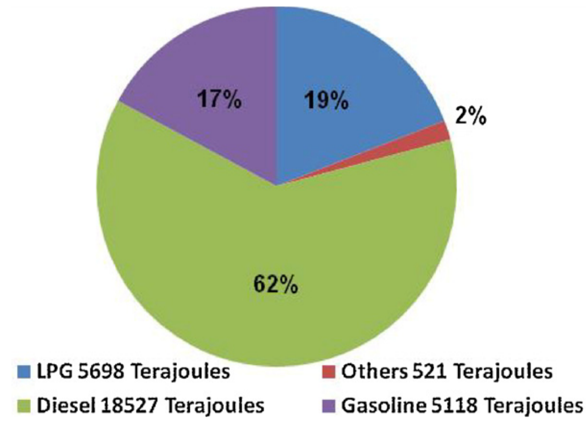

Fig. 2. Breakdown of fossil fuels imports in the Palestinian Territories [6].

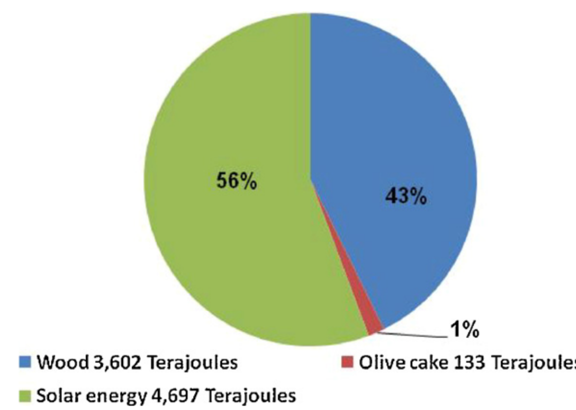

Fig. 3. Breakdown of renewable energy sources in the Palestinian Territories [6].

imports. Fig. 4 shows the quantity and source country of electricity purchases in the Palestinian Territories: 9% of electricity was generated in the Gaza Strip by the Palestine Electric Company The rest was imported from Jordan to power Jericho in the West Bank; from Egypt to power Rafah in the Gaza Strip; and from Israel to power most of the West Bank and the Gaza Strip [6].

The Palestinian reliance on Israel for the majority of its fuel imports is complicated not only by the political situation but also by the fact that Israel relies predominantly on fossil fuels for its own electricity, as well. The Palestinian energy demand is an additional burden on Israeli production and distribution systems, which are overtaxed as is with domestic, rapidly increasing needs.

3. Renewable energy potential in the Palestinian Territories

In contrast to the dearth of traditional energy sources on Palestinian land, there are promising supplies of natural resources, such

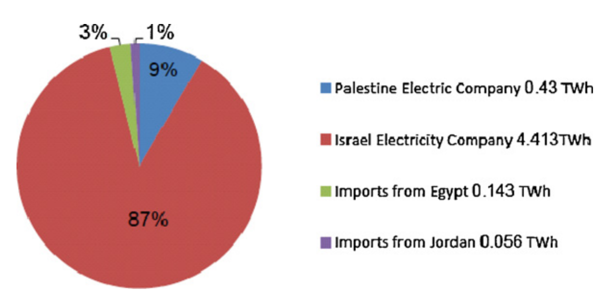

Fig. 4. Quantity and country of electricity purchases (TWh) in the Palestinian Territory [6].

Table 1
Solar irradiation in the Jordan Valley in kWh/m^2 per day [7].

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual average
22-year average	4	4.23	5.23	6.43	8.63	8.32	7.3	6.68	5.13	4.45	3.88	3.88	5.98

as solar, biomass and wind energies, for the production of non-traditional energy. Even with a resolution to the political crisis between Israel and the Palestinian Territories, and even if the Gaza Power Plant were generating electricity at its maximum capacity, fomenting the renewable energy sector in the Palestinian Territories would be in Palestinian interests for environmental, economic, political and security reasons.

The first step toward Palestinian energy independence and security would be the development of its renewable energy sources, both for large-scale energy production and smaller-scale, stand-alone systems. The sources, technology and knowledge exist to develop this sector in the Palestinian Territories, even if political, technical and financial challenges abound. This will exists as well: the Palestinian Energy and Environment Research Center, established in 1993 as a precursor to the Palestinian Energy Authority, was charged at its inception with developing proposals for a renewable energy and energy efficiency law. Such a law was never addressed or enacted by the Palestinian Legislative Council, however, due to the ongoing political crisis.

Nonetheless, as political conditions evolve, the Palestinian government, private sector and individual communities may consider more seriously tapping the potential of the various renewable energies discussed here. Presently, there are few small-scale renewable energy projects in operation, aside from the widespread use of solar water heaters, which approximately 70% of Palestinian homes have [6]. There are only plans for large-scale, regional renewable energy systems.

3.1. Solar energy

According to the U.S. National Aeronautics and Space Administration, parts of the West Bank, in the Jordan Valley, receive high radiation levels: 5.40–5.98 kWh/m^2 per day annually [7]. Total annual sunshine is approximately 3000 h [8]. These are excellent conditions for harnessing solar energy for both large-scale and stand-alone applications. The Jordan Valley is conducive to hosting a solar field for another reason: it is the least densely populated region in the Palestinian Territories.

The area of Jericho and the Jordan Valley is about 10% of total Palestinian land (593 km^2 out of 6020 km^2). Table 1 details the monthly average of solar radiation in the Jordan Valley over the course of 22 years.A photovoltaic power plant (polycrystalline silicon with an efficiency of 11%) with an area of 8 km^2 can generate 500 MW of electricity. This field could cover 1.34% of the land in the Jordan Valley and could generate around 600 GWh per year (approximating 5 sun hours, 300 days and a performance ratio of 0.8). Such a field could account for 11% of current Palestinian electricity needs. Similar photovoltaic or solar thermal power plants could be installed in the northern regions of the West Bank as well, such as in the Jenin and Nablus areas where the average solar radiation ranges from 5.4 to 5.9 kW/m^2 per day [7].

Rooftop photovoltaic installations can play a small role in providing electricity to the Palestinian grid as well. Nearly 130,000 houses built between 1997 and 2010 in the Palestinian Territories have an average area of 150 m^2 each. Using only 10% of the rooftop area for photovoltaic installation would generate around 146 GWh per year (5 sun hours, 300 days and a performance ratio of 0.8). Such rooftop installations would cover approximately 2.7% of the Palestinian electricity needs.

Despite this high potential for solar energy sources, the extent of the sector's development is limited for an array of reasons, which either prohibit its development entirely beyond a certain point or which significantly raise the costs and risks of investing in the sector. In general, solar projects require great degrees of financing, technology, organization, expertise, institutional support and infrastructure for design, construction, maintenance, grid connection, energy storage, transmission and distribution. The development of social and political support for a project, obtaining rights to land and the legal permission to build, financing construction and maintenance, the design of a utility based on the social, technical and financial factors and the management of a power plant are formidable challenges anywhere.

In the Palestinian Territories, the political situation and its many ramifications weigh down on top of these standard issues: Israeli control of Area C; prohibitions on building infrastructure; land availability and rights; and border restrictions on transporting construction materials into Gaza.

Still, there are instances of renewable energy projects, in addition to the solar water heaters, that surmount some of these challenges. Palestinian universities and non-governmental organizations (NGOs) and Israeli-Palestinian NGOs have built highly successful solar, wind and hybrid power systems in Palestinian villages in the West Bank. These cases demonstrate that it is feasible, under certain conditions, to acquire the financing, share the technical knowledge, assess community needs and involve the community in the project's entire development to build the infrastructure for a utility to function and for the energy to be used to the community's advantage and satisfaction. Most of these photovoltaic systems in the Palestinian Territories have a generation capacity of 10–20 kW per unit.Meanwhile, Israel is taking a lead in renewable energy validation and implementation. In theory and in a few actual cases, as with the organization Community, Energy, Technology in the Middle East (Comet-ME), Palestinians and Israelis are sharing knowledge, techniques and resources to produce not only concrete, constructive outcomes when the technology is applied in Palestinian villages but also opportunities for positive interactions between countries.

3.2. Biomass

Biomass is considered a strategic energy resource since it may be grown almost anywhere, since it contributes to environmental protection and since it is a source of fuel for motor vehicles. Biomass is of great importance both for developed and developing countries [9].

Biomass energy includes both traditional uses (e.g., burning for cooking and heating) and modern uses (e.g., producing electricity, steam and liquid biofuels). Currently, biomass energy contributes 9–13% of the global energy supply and approximately 8% of Palestinian energy supply.

The Palestinian Territories is known, historically, for its agriculture and trading. Agriculture is still a predominant economic activity [10]. As a result, the Palestinian Territories has a strong potential for biomass energy. People living in rural areas may benefit from producing biomass energy in various forms, including from wood, crop residues and biogas.

Presently, no crops are grown in the Palestinian Territories specifically for use as fuel. This section discusses the estimated

Table 2
Number of cattle in the Palestinian Territories by type in years 2007 and 2008 [6].

Livestock type	Number of heads
Cattle	33,000
Goat	322,000
Sheep	689,000

available potential of biogas and agricultural residue converted into energy.

3.2.1. Biogas

The biogas industry is well developed in parts of the world, especially in China and India. Approximately 6.8 million household bio-digesters and 1000 medium- and large-size bio-digesters existed in China in 2007, with a production of 2 million m^3. This amounts to 5% of total gas energy in China [11]. This technology may be applied easily in the Palestinian Territories.

Table 2 shows the amount of livestock in the Palestinian Territories. The manure may be used to generate methane gas through the natural, biological process of anaerobic digestion.

The following calculations demonstrate the biogas potential. On average, the daily dung dropping of medium-size cattle is estimated at 10 kg, or 330,000 kg of manure per day, with 33,000 head of cattle [12–14]. Assuming 50% collection, the availability of fresh manure in the Palestinian Territories amounts to approximately 165,000 kg per day. If 20 kg of wet mass of manure produces 1 m^3 of gas at 25 °C, then the total biogas production for the Palestinian Territories' amount of cattle would be 8250 m^3 per day [15].

The daily dung dropping of a sheep or goat is estimated at 0.1 kg, yielding a total of 100,000 kg of manure per day in the case of the Palestinian Territories' approximate million head of goats and sheep [12,13]. Assuming 50% collection, the availability of fresh manure amounts to 50,000 kg per day. Based on the literature, 6 kg of wet mass produces 0.5 m^3 gas per day at 25 °C [12–15]. Therefore, the total biogas production from sheep and goat manure could amount to 4166 m^3 per day.

Combined with the cattle's biogas production, the Palestinian Territories could produce 12,416 m^3 of biogas per day or approximately 4.5 million m^3 per year. Since 0.2–0.4 m^3 of gas suffices for the cooking needs of one person per day, the 12,416 m^3 of biogas per day could meet the cooking needs of 62,000 to 124,000 people per day, depending upon their consumption rate [16]. The total population of the Palestinian Territories is 3.76 million, out of which 17%, or 630,000 people, reside in the rural areas. Thus, biogas could account for 10–20% of cooking energy needs for the rural population. In addition, the biogas production could provide nitrogen-enriched bio-fertilizer to improve the fertility of agricultural lands (approximately 30,000 kg per day by these estimates) [15].

The distribution of livestock in the Palestinian Territories can minimize the cost of manure collection and is conducive to efficient, central biogas plants. Approximately 48% of cattle and 37% of goats and sheep in the West Bank are in a 25 km^2 area in the northern West Bank (Nablus, Jenin, Tubas and Qalqilya). Another 41% of cattle and 30% of goats and sheep are located in Hebron. One efficient approach would be to set up small-scale digesters in rural areas where farms are located. This set-up would reduce significantly the energy expenditure and cost of transferring the manure to a central location.

Biogas projects in rural communities offer numerous benefits and fewer challenges than other potential renewable energy-based or traditional energy projects. The main non-technical challenges of establishing a local biogas project would include obtaining the legal permission to install and produce energy from the bio-digester, ensuring the financial viability of the project and addressing the social issues that typically emanate from a shared or new community project.

If the challenges could be mitigated, biogas has the potential to be a reliable source of energy at low cost and using accessible technology and material. It would be a boon to many rural regions of the West Bank, particularly in South Mount Hebron and the Jordan Valley, that lack access to the main electricity grid. In addition to the direct benefit of providing energy, biogas could generate positive health, education and economic impacts as well. With access to electricity, communities dependent on agriculture for subsistence living could produce additional products to make small profits – cheese to sell, for instance. Electricity would enable refrigeration of such goods until the most profitable day to sell at the market. Thus, a secondary effect would be increasing women's autonomy and economic wellbeing.

In the Gaza Strip, the production of energy from biogas would offer the additional benefit of preventing a large quantity of animal waste from entering and polluting the water and groundwater systems, which are already highly contaminated and a source of health problems.

3.2.2. Agricultural residues

Low-cost crop and forest residues, wood process waste and the organic portion of municipal solid waste can be used as lignocellulosic feedstocks. Where these biomass materials are available, it should be possible to produce biofuel from them with negligible additional land requirements or impacts on food and fiber crop production. The technical potential from available annual supplies of residues and wastes has been estimated in energy terms at over 100 EJ per year at delivered costs of two to three U.S. dollars per 1 GJ [17].

Agricultural residues and food processing wastes from agro-industry represent an important source of biomass with widespread availability. Table 3 gives the amounts of agricultural production and residue in the Palestinian Territories. Unal and Alibas [9] categorized very well the agricultural waste according to its appearance. Their method is used here in categorizing the agricultural waste. Tables 3 and 4 give the amount of unused, dry agricultural residue in the Palestinian Territories. In each table, the residues are separated into Categories A and B according to their physical appearance: Category A is generally straw, stems and leaves, while Category B consists of the pruning residues of the fruit trees. The residue/product ratios were determined by talking to farmers or from the existing literature. The total mass of the unused dry residues in Categories A and B are 59,329 and 54,479 tons, respectively. Taking into account the high heating value of 17.1 MJ/kg for category A and 18.5 MJ/kg for Category B, the amount of extractable energy is 2 TJ [9,17–21]. This energy can be extracted for electricity production through biomass gasification.

Beside the gasification process, the production of biofuels from agricultural residue (ligno-cellulosic feedstock) can be achieved through a biochemical process to produce ethanol or through a biomass-to-liquid (BTL) thermochemical process to generate biodiesel. Typically, the BTL route yields up to 200 l of synthetic diesel per dry ton of residues, which means 22,800 tons of diesel can be generated for the agricultural residues [22]. This could account for nearly 5% of the national diesel consumption.Wind energy

The use of wind energy technology has developed very quickly in recent years. Given that wind power is a local resource and that it is clean and environmentally friendly, it is critical to conduct required technical and economic feasibility studies in order to make use of this energy.

The effective utilization of wind energy entails a detailed knowledge of the wind characteristics at the particular location. The distribution of wind speeds is important for the design of wind farms, power generators and agricultural applications like

Table 3
Agricultural products and residue from vegetables, fruits and field crops in the Palestinian Territories.

Crop	Production in 2008 (tons)	Type of residue	Residue/product ratio [8,16–20]	Mass of wet residue (tons)
Category A				
Wheat	31,826	Straw	1.36	43,283
Barley	9740	Straw	1.06	10,324
Potato	74,075	Stems and leaves	0.45	33,334
Chick peas	1741	Stems and leaves	2.27	3952
Cucumber	208,182	Stems and leaves	0.3	62,454
Squash	48,506	Stems and leaves	0.3	14,552
Tomato	207,559	Stems and leaves	0.30	62,268
Maize	12,481	Stalks	3	37,443
Cabbage	22,376	Foliage and stems	2.5	55,940
Total				323,550
Category B				
Olive	85,651	Pruning	1.37	117,341
Orange	38,057	Pruning	0.22	8372
Lemon	15,421	Pruning	0.28	4318
Plum	8667	Pruning	0.35	3033
Fig	6518	Pruning	0.45	2933
Date	3997	Pruning	0.50	1999
Almond	6230	Pruning	2.74	17,070
Peach	1577	Pruning	0.30	473
Apricot	1304	Pruning	0.35	456
Apple	1269	Pruning	0.47	596
Cherry	1096	Pruning	0.83	910
Total				157,501

irrigation. It is not a simple task to choose a site for a wind turbine because of these numerous factors. The most important factors that have to be taken into account when designing the wind farm are: wind speed, the energy of the wind, the generator type and the results of the feasibility study. Long-term wind velocity measurements are imperative for a good wind energy assessment. The longer the period of collected data, the more reliable the estimated wind potentials.In the Palestinian Territories, there are no such long-term measurements. Therefore, to estimate the wind energy potential in the Palestinian Territories, NASA's Surface meteorology and Solar Energy data set was used [7]. Several researchers around the world use this data set [23–27]. Unlike surface measurements, this data set is a consistent, 10-year global average on a 1° by 1° (about 100×100 km) grid. The SSE data, essentially an average over the entire area of the cell, may not represent a particular site within the grid. Yet this database is an excellent, accessible source that could be used for a preliminary study for renewable energy resource estimation. The SSE data set is not intended to replace quality ground measurement data [28]. It is intended to supplement measurements for areas where ground measurements are missing and to support research on areas where ground measurements do exist.

Table 5 shows the annual and monthly average wind speeds at 10 and 50 m for the northern and southern West Bank [7]. These values are in agreement with the values obtained for short-term measurements in the West Bank (source: Imad Ibrik, personal communication). For both locations, the annual average speeds are above 4 m/s. The wind speed value of 4–6 m/s is of particular interest since it is typically only at wind speeds above this threshold that turbines operate effectively [29,30] However, this wind speed range can be used for small wind turbines' electricity generation. For a modern wind turbine, the minimum (cut-in) wind speed

Table 4
Moisture and unused residue quantities [9].

Crop	Mass of wet residue (ton)	Residue moisture (%) [9]	Residue dry mass	Used ratio	Unused residue quantity
Category A					
Wheat	43,283	15	36,790.55	85	5518.583
Barley	10,324	15	8775.4	85	1316.31
Potato	33,334	60	13,333.6	5	12,666.92
Chick peas	3952	15	3359.2	10	3023.28
Cucumber	62,454	85	9368.1	5	8899.695
Squash	14,552	85	2182.8	5	2073.66
Tomato	62,268	85	9340.2	5	8873.19
Maize	37,443	60	14,977.2	40	8986.32
Cabbage	55,940	85	8391	5	7971.45
Total					59,329
Category B					
Olive	117,341	40	70,404.6	50	35,202.3
Orange	8372	40	5023.2	20	4018.56
Lemon	4318	40	2590.8	20	2072.64
Plum	3033	40	1819.8	20	1455.84
Fig	2933	40	1759.8	20	1407.84
Date	1999	40	1199.4	20	959.52
Almond	17,070	40	10,242	20	8193.6
Peach	473	40	283.8	20	227.04
Apricot	456	40	273.6	20	218.88
Apple	596	40	357.6	20	286.08
Cherry	910	40	546	20	436.8
Total					54,479.1

Table 5
Monthly and annual average wind speeds (m/s) for the northern and southern West Bank [7].

Monthly average	10-year average wind speed (m/s) Northern West Bank		Southern West Bank	
	10 m	50 m	10 m	50 m
Jan	4.76	6.02	4.45	5.63
Feb	4.88	6.19	4.59	5.81
Mar	4.95	6.26	4.72	5.98
Apr	4.46	5.65	4.36	5.52
May	4.17	5.28	4.09	5.19
Jun	4.23	5.36	4.13	5.23
Jul	4.30	5.45	4.13	5.23
Aug	4.09	5.18	3.92	4.96
Sep	3.74	4.73	3.64	4.61
Oct	3.69	4.67	3.65	4.62
Nov	3.79	4.80	3.65	5.62
Dec	4.40	5.57	4.13	5.23
Annual average	4.28	5.42	4.12	5.21

required for a turbine to start generating electricity is generally between 3 and 5 m/s and depends on the size of the turbine.At 100 m in height, the wind speed will be 5.7 and 6 m/s in the northern and southern West Bank, respectively. Using a 100-m wind turbine with blade length of 52 m and power coefficient of 0.4, the annual power that can be generated is 3.3 and 3.8 GWh for the northern and southern West Bank, respectively. Using a wind farm of 50 turbines, each would generate 355 GWh/year, which could account for 6.6% of the electricity need in the Palestinian Territories.The high density of buildings and the scarcity of open and empty lands in the Gaza Strip obviate the possibility of building wind farms there. However, offshore wind farms could be installed in the Mediterranean Sea, were it not for present political obstacles.Today, the only large-scale wind turbine in the Palestinian Territories is at the Al-Ahli Hospital in Hebron. This turbine provides 40% of the hospital's energy needs [31].

The low speed winds in the Palestinian Territories may encourage using wind energy in stand-alone systems to provide small electricity loads, such as for water pumping, grain grinding and other purposes. Indeed, wind energy could make an important contribution to meeting the energy needs for development in rural areas, where 17% of the Palestinian population resides. Wind energy can be used to pump water that is stored in tanks and reservoirs or absorbed in the ground as well. This capacitor-like property gives smoothing to the intermittent wind source and makes wind-powered pumping more economical. Farm scale pumps, of up to approximately 10 kW power, are common in many countries including Argentina, Australia and the United States. These pumps can be easily used in rural areas of the Palestinian Territories to replace the diesel engines that are heavy polluters. Thus, the use of wind energy for water pumping provides a valuable opportunity for meeting rural water needs.

4. Challenges to developing the renewable energy sector

Palestinian and international investors are skilled in assessing the macroeconomic pitfalls in the renewable energy sector. However, they do not always take into account a whole series of risks that are more difficult to calculate such as corruption, politics, an uncertain regulatory environment and bureaucratic delays. All of these risk factors raise the need for caution when choosing to invest in the field of renewable in the Palestinian Territories.

As mentioned with regard to the specific potential renewable energy technologies, the political, technical and financial challenges to developing this energy sector are formidable. Each type of challenge and the confluence of them constitute major deterrents to many investors. Risk and uncertainty pervade most investments in the Palestinian Territories, given the decades-long pattern of violence and insecurity in the Palestinian Territories, the Israeli military occupation and the lack of Palestinian sovereignty over the land. The investment risk today is, arguably, greater than usual with the Arab Spring in 2011, whose impact on Palestinian issues is yet to be seen in full, and with the present push for Palestinian statehood before the United Nations.

Investment risks are even more severe, if not fully prohibitive, in the Gaza Strip given the degree, historically, of economic embargoes, border closures and the destruction of infrastructure during wars and other military acts.

Nonetheless, some investors with the capacity and will to take the risks of investing in the Palestinian Territories' energy sector and other sectors have been successful. Moreover, the nature and severity of the risks vary by project and it is conceivable that international political issues and standing for the Palestinian Territories will evolve in the near future.

5. Conclusion

The Palestinian Territories relies mostly on Israel for its fossil fuel and electricity imports. Dependence on the Israeli and other foreign sources is costly in environmental, economic and political terms. The Palestinian Territories has the potential to reduce this reliance by producing its own energy from renewable sources.

If used, the available renewable energy sources, such as solar, wind and biomass, could replace more than 25% of the current Palestinian energy demand. However, any activity in the energy sector, traditional or alternative, would encounter a number of challenges, including: political impediments to developing the institutions, implementing the policies, building the physical infrastructure and controlling the borders and trade and transit across them. Most energy initiatives would have to overcome the challenge of geographic isolation between the Gaza Strip and West Bank and East Jerusalem and between areas within the West Bank and East Jerusalem as a result of the politically imposed divisions and the lack of full Palestinian control over major portions of the land. A majority of the renewable energy sources and Palestinian land is found in Area C, which are not under Palestinian control at the time of this writing. The political situation and conflict generally discourage investment in the energy field, given the high political and financial risks and volatility. These circumstances also lead to a higher rate of project abandonment.

However, a subset of these challenges would be less relevant or less detrimental in the context of renewable energy than they are with traditional energy sources and industries. Renewable energy systems and applications can be built, at least initially, on a local level (family, village, municipality or region) and do not require interconnection with other locations across geographic, political or administrative boundaries. Smaller scale renewable energy projects may be done at lesser costs and thus may not require major domestic or foreign investment initially. A demonstrated success at the pilot project level may encourage investment in the future.

Thus, while obstacles remain, to construct renewable energy projects in the Palestinian Territories could offer higher chances of feasibility than traditional energy projects and could hold added value. Renewable sources may provide energy to populations in great need of it, both for a more stable subsistence lifestyle and for incremental economic growth, even before major political changes take place. As off-grid communities, in particular in the West Bank, establish a local capacity to generate energy, they strengthen their future local and national public infrastructure, technical capacity

and knowledge base from the ground-up. Building this vital, physical infrastructure and strengthening livelihoods in village locations is additionally important for people whose right to their land is contested and threatened.

With its high potential to generate energy from renewable sources, the Palestinian Territories could reduce its vulnerability to political, economic and security shocks. Renewable energy could help lay a foundation both for a future, sustainable state and for future energy relations with Israel and elsewhere based on interdependence instead of dependence.

Lastly, it is noteworthy that the need for technical training for Palestinians to build and maintain renewable energy systems – and the need for non-technical community awareness programs related to renewable energy – may present opportunities with secondary and tertiary positive ramifications. There are existing examples of effective technical trainings done in concert between Palestinian individuals, organizations and communities and Israeli, Jordanian and international entities. These trainings are ideal for sharing scientific knowledge and the latest technologies and skills as well as for engaging colleagues, counterparts and students across political boundaries. The need for a social, community-based program to accompany any renewable energy project that serves a family, community or larger region offers opportunities for organization and leadership within Palestinian communities and with youth in particular.

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